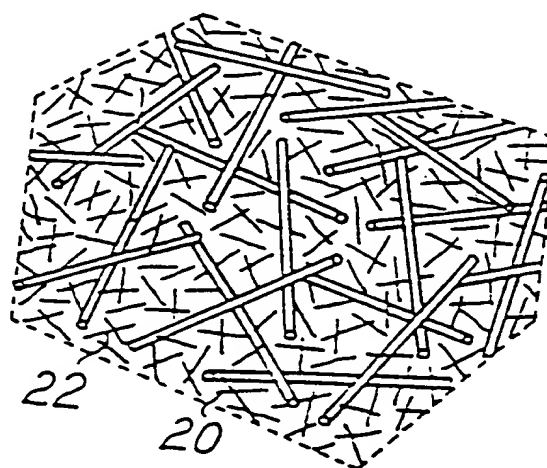




BY THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>4</sup> : <b>D01F 8/06</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 89/10989</b> (43) International Publication Date: <b>16 November 1989 (16.11.89)</b></p>
<p>(21) International Application Number: <b>PCT/DK89/00102</b> (22) International Filing Date: <b>2 May 1989 (02.05.89)</b> (30) Priority data: <b>2454/88</b> <b>5 May 1988 (05.05.88)</b> <b>DK</b> (71) Applicant (for all designated States except US): <b>DANAK-LON A/S [DK/DK]; Engdraget 22, DK-6800 Varde (DK).</b> (72) Inventors; and (75) Inventors/Applicants (for US only): <b>HANSEN, Anders, Staf [DK/DK]; Vestparken 17, DK-6840 Oksboi (DK). MARCHER, Bjorn [DK/DK]; Lyngbyvej 347B, DK-2820 Gentofte (DK). SCHLOSS, Peter [DK/DK]; Vag-telvej 51, DK-2000 Frederiksberg (DK).</b> (74) Agent: <b>PLOUGMANN &amp; VINGTOFT; Sankt Annæ Plads 11, DK-1250 Copenhagen K (DK).</b></p>		<p>(81) Designated States: <b>AU. BR. DK. FI. JP. KR. NO. SU. US.</b>  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i></p>

(54) Title: **BICOMPONENT SYNTHETIC FIBRE AND PROCESS FOR PRODUCING SAME**



(57) Abstract

A thermobondable bicomponent synthetic fibre (8, 14) with a length of at least about 3 mm, adapted to use in the blending of fluff pulp for the production of hygiene absorbent products, the fibre comprising an inner core component (10, 16) and an outer sheath component (12, 18), in which the core component comprises a polyolefin or a polyester, the sheath component comprises a polyolefin, and the core component has a higher melting point than the sheath component, and a process for producing said fibre. The sheath-and-core type fibre is preferably made permanently substantially hydrophilic by incorporating a surface active agent into the sheath component. The long bicomponent fibres (20) form a strong supporting three-dimensional matrix structure (20, 24) in the absorbent product upon thermobonding.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FI	Finland	ML	Mali
AU	Australia	FR	France	MR	Mauritania
BB	Barbados	GA	Gabon	MW	Malawi
BE	Belgium	GB	United Kingdom	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IT	Italy	RO	Romania
BJ	Benin	JP	Japan	SD	Sudan
BR	Brazil	KP	Democratic People's Republic of Korea	SE	Sweden
CF	Central African Republic	KR	Republic of Korea	SN	Senegal
CG	Congo	LI	Liechtenstein	SU	Soviet Union
CH	Switzerland	LK	Sri Lanka	TD	Chad
CM	Cameroon	LU	Luxembourg	TG	Togo
DE	Germany, Federal Republic of	MC	Monaco	US	United States of America
DK	Denmark	MG	Madagascar		
ES	Spain				

BACKGROUND OF THE INVENTION  
BICOMPONENT SYNTHETIC FIBRE AND PROCESS FOR PRODUCING SAME

The present invention relates to a long thermobondable bicomponent synthetic fibre adapted to use in the preparation of absorbent material, and a method for making the fibre and an absorbent material incorporating same. More specifically, the invention relates to a fibre comprising an outer sheath component and an inner core component, the core component having a higher melting point than the sheath component. The fibre is preferably permanently substantially hydrophilic. The term "hydrophilic" refers to the fact that the fiber has an affinity for water, and thus is easily dispersed in water or aqueous mixtures. This affinity may be ascribed to the presence of polar groups on the fibre's surface. The term "permanently" substantially hydrophilic refers to the fact that the fibre will retain its hydrophilic properties after repeated dispersions in water. This may be obtained by incorporating a surface active agent or a hydrophilic polymer or copolymer into the sheath component of the fibre or by producing a fibre in which the sheath component comprises a hydrophilic polymer or copolymer. The fibre of the present invention is useful in the preparation of "fluff", which is a fluffy fibrous material used as an absorbent and/or liquid-conducting core in the production of hygiene absorbent products such as disposable diapers. Fluff is produced by defibrating and dry forming so-called "fluff pulp", which is comprised of natural and/or synthetic fibres.

There has been a trend in recent years towards stronger, thinner and lighter weight disposable diapers, and other disposable hygiene absorbent products. One factor in this trend has been the development of a number of synthetic fibres, notably heat-adhesive (thermobondable) synthetic fibres, which have been used to replace at least some of the natural cellulose fibres in these products. Such thermobondable synthetic fibres are typically used to bond the cellulose fibres together, thereby achieving an absorbent material with improved strength and allowing the production of thinner and lighter weight products. Examples of patents describing such fibres, or their use or production, are U.S. patents Nos. 4,189,338 (non-

woven fabric comprising side-by-side bicomponent fibres), 4,234,655 (heat-adhesive composite fibres), 4,269,888 (heat-adhesive composite fibres), 4,425,126 (fibrous material using thermoplastic synthetic fibres), 4,458,042 (absorbent material containing polyolefin pulp treated with a wetting agent) and 4,655,877 (absorbent web structure containing short hydrophilic thermoplastic fibres), and European patent application No. 0 248 598 (polyolefin-type nonwoven fabric).

However, the use of these synthetic fibres in absorbent products has not been without problems. One problem which may be encountered is that it can be difficult to distribute the synthetic fibres into fluff pulp produced by a wet process, since these synthetic fibres are generally of a hydrophobic nature. Such hydrophobic fibres repel water, and therefore have a tendency to form conglomerations in the fluff pulp or to float at the surface of the wet fluff pulp if they are lighter than water. If the synthetic fibres are also distributed unevenly in the fluff, than barriers which hinder the transport of moisture may be created in the absorbent product, due to the fusion of the thermobonded fibres to each other in areas where there is a conglomeration of such fibres. Furthermore, the synthetic fibres currently used in the production of fluff are generally quite short, i.e. normally shorter than the cellulose fibres which typically comprise a substantial portion of the fluff. The supporting structure of the absorbent material is therefore formed by the cellulose fibres in the material, and since absorbent cores of such natural cellulose fibres have a tendency to break under the stress and bending to which, for example, diapers are subjected, wicking barriers are easily formed. Absorbent cores which consist only of natural cellulose fibres, i.e. which do not contain any synthetic fibres, may likewise also be subject to breakage and formation of wicking barriers due to stress and bending.

Hygiene absorbent products often include a so-called super absorbent polymer, in the form of a powder or small particles, which is incorporated into the material in order to achieve a weight reduction. However, the super absorbent polymer in these materials often has a tendency to sift out of the position in which it was

originally placed, due to the lack of a structure which can effectively retain the small particles.

The long bicomponent synthetic fibre of the present invention addresses the problems mentioned above. The bicomponent fibres of the present invention are substantially longer than other fibres typically used in the preparation of fluff. During the production of absorbent products from fluff containing the bicomponent fibre, the fluff is subjected to a heat treatment (thermobonding), in which the sheath component of the bicomponent fibre is melted, while the high melting core component of the fibre remains intact. The core component of the long bicomponent fibres are thus fused together by the melting of the sheath component, forming a strong uniform supporting three-dimensional matrix in the absorbent material. The absorbent material is thus able to withstand flexing without developing wicking barriers due to breakage of the absorbent core. In addition, the matrix structure formed by the bicomponent fibres gives the material improved shape retention under dynamic stress during use of the absorbent product.

The three-dimensional mesh-like structure formed by the high melting component of the bicomponent fibres in the thermobonded material enables the super absorbent polymer to be held in the desired position. This is a further advantage, giving a more efficient use of the super absorbent polymer and helping to increase porosity, as well as giving the possibility of producing lighter weight absorbent materials.

In addition, the low melting sheath component has preferably been made permanently substantially hydrophilic, thus allowing the fibres to be distributed homogeneously in the wet-processed fluff pulp which is typically used in the preparation of absorbent material. It is also desirable that the fibres in the finished product are hydrophilic, so that the product's absorbent and liquid-conducting properties are not impaired, as may be the case in a product with a substantial content of hydrophobic fibres.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a thermobondable bicomponent synthetic fibre with a length of at least about 3 mm, adapted to use in the blending of fluff pulp, comprising an inner core component and an outer sheath component, in which

- the core component comprises a polyolefin or a polyester,
- the sheath component comprises a polyolefin, and
- the core component has a higher melting point than the sheath component.

As will be explained below, the fibre is preferably permanently substantially hydrophilic.

In a sheath-and-core type bicomponent fibre, the core component is surrounded by the sheath component, as opposed to a side-by-side or bilateral type bicomponent fibre, in which the two components both have a continuous longitudinal external surface. However, a small portion of the core component may be exposed at the surface in the case of a so-called "acentric" sheath-and-core fibre, as explained below.

The sheath component of the bicomponent fibre is selected from the group of polyolefins, while the core component may comprise a polyolefin or a polyester. The core component typically has a melting point of at least about 150°C, preferably at least about 160°C, and the sheath component typically has a melting point of about 140°C or lower, preferably about 135°C or lower. The two components of the fibre thus have melting points which are significantly different from each other, allowing the low melting sheath component to be melted in a thermobonding process, while the high melting core component remains substantially intact. While specific melting points are named in the following, it must be kept in mind that these materials, as all crystalline polymeric materials, in reality melt gradually over a range of a few degrees. However, this is not a problem, because the two components of the fibre will in practice be chosen such that their melting points are substantially different from each other.

- Preferably, the fibre includes a sheath component comprising a low melting polyolefin such as high density polyethylene (melting point (m.p.) about 130°C), low density polyethylene (m.p. about 110°C), linear low density polyethylene (m.p. about 125°C), or poly(1-butene) (m.p. about 130°C), or mixtures or copolymers of the above, together with a core component comprising a polyolefin such as polypropylene (m.p. about 160°C). The sheath component can furthermore comprise an ethylene-propylene copolymer based on propylene with up to about 7% ethylene (m.p. about 145°C).
- 10 The fibre according to the present invention may also include a core component comprising poly(4-methyl-1-pentene) (m.p. about 230°C), and a sheath component comprising any of the above mentioned polyolefins (i.e. high density polyethylene, low density polyethylene, linear low density polyethylene, poly(1-butene) or polypropylene).
- 15 Alternatively, the core component may comprise a polyester with a high melting point (i.e. above about 210°C), such as poly(ethylene-terephthalate) (m.p. about 255°C), poly(butylene-terephthalate) (m.p. about 230°C), or poly(1,4-cyclohexylene-dimethylene-terephthalate) (m.p. about 290°C), or other polyesters, or copolyesters comprising
- 20 the above-mentioned structures and/or other polyesters. If the fibre includes a polyester core, the sheath may comprise any of the materials mentioned earlier (e.g. high density polyethylene, low density polyethylene, linear low density polyethylene, poly(1-butene), polypropylene, or copolymers or mixtures of these
- 25 materials), or another material with a melting point of about 170°C or lower.

In addition, the sheath component may comprise a mixture of, for example, low density polyethylene and either an (ethyl vinyl acetate) copolymer or an (ethylene acrylic acid) copolymer (m.p. about 100°C), as explained below.

30

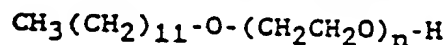
The composition of the two components of the fibre can thus be varied to include a number of different basic materials, and the exact composition in each case will obviously depend on the material in which the fibre is to be used, as well as the equipment and

production processes used to prepare the absorbent material in question.

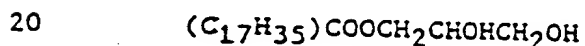
The fibre has preferably been given permanent hydrophilic surface properties, typically by incorporating a surface active agent into the sheath component or by including a hydrophilic polymer or copolymer in the sheath component. However, the fibre may possibly also be made permanently substantially hydrophilic by treatment of the surface with a surface active agent.

In the case of incorporation of a surface active agent into the sheath component, the surface active agent may typically be chosen from compounds normally used as emulsifiers, surfactants or detergents, and may comprise blends of these compounds. Examples of such compounds are fatty acid esters of glycerides, fatty acid amides, polyglycol esters, polyethoxylated amides, nonionic surfactants and cationic surfactants.

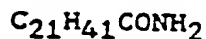
Specific examples of such compounds are a polyethylene glycol-lauryl ether, which has the formula:



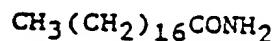
glycerol monostearate, which has the formula:



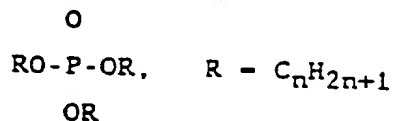
erucamide, which has the formula:



stearic acid amide, which has the formula:



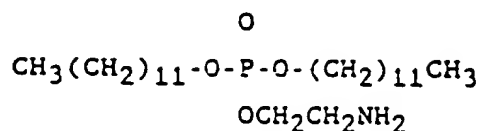
a trialkyl-phosphate, which has the formula:



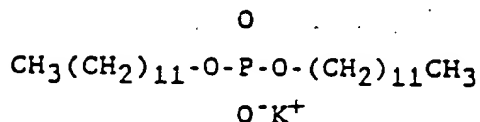


7

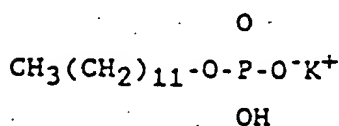
alkyl-phosphate-amine ester, which has the formula:



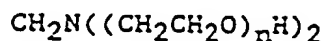
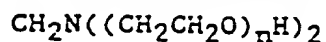
5 a lauryl phosphate-potassium salt, which has the formula:



or:



and an ethylenediamine-polyethylene glycol, which has the formula:



The compounds should preferably have a hydrophobic part to make them compatible with the olefinic polymer, and a hydrophilic part to make the surface of the fibre wettable. Blends of compounds can be used to control the hydrophilic properties. The surface active agent is typically incorporated into the sheath component in an amount of about 0.1 - 5%, and preferably about 0.5 - 2%, based on the total weight of the fibre. This amount of surface active agent is sufficient to give the fibre the desired hydrophilicity, without having any adverse effects on other properties of the fibre.

The sheath component may additionally comprise a hydrophilic polymer or hydrophilic copolymer. Examples of such a hydrophilic copolymer are (ethyl vinyl acetate) copolymer and (ethylene acrylic acid) copolymer. In this case, the sheath component may comprise, in addition to the surface active agent as described above, a mixture of, for example, about 50-75% low density polyethylene and about 50-25% of the hydrophilic copolymer, and the amount of vinyl acetate or acrylic acid, respectively, will typically be about 0.1 - 5%, and preferably about 0.5 - 2%, based on the total weight of the fibre.

The fibres can be tested for hydrophilicity by, for example, measuring the time required for them to sink in water, e.g. according to European Disposable Non-woven Association standard No. 10.1-72. The fibres may be placed in a metal net on the surface of the water, and they may be defined as being hydrophilic if they sink below the surface within about 10 seconds, and preferably within about 5 seconds.

The weight ratio of the sheath and core components in the bicomponent fibre is preferably in the range of about 10:90 to 90:10. If the sheath component comprises less than about 10% of the total weight of the fibre, it may be difficult to achieve sufficient thermobonding of the core component to other fibres in the material. Likewise, if the core component comprises less than about 10% of the total weight of the fibre, it may not be possible for the thermobonded core component to lend sufficient strength to the finished product. More specifically, the weight ratio of the sheath and core components will typically be from about 30:70 to 70:30, and preferably from about 40:60 to 65:35.

The cross section of the bicomponent fibre is preferably circular, since the equipment typically used in the production of bicomponent synthetic fibres normally produces fibres with a substantially circular cross section. However, the cross section may also be oval or irregular. The configuration of the sheath and core components can be either concentric or acentric (as illustrated in Fig. 1), the latter configuration sometimes being known as a "modified side-by-side" or an "eccentric" bicomponent fibre. The concentric configuration is characterized by the sheath component having a substantially uniform thickness, such that the core component lies approximately in the centre of the fibre. In the acentric configuration, the thickness of the sheath component varies, and the core component therefore does not lie in the centre of the fibre. In either case, the core component is substantially surrounded by the sheath component. However, in an acentric bicomponent fibre, a portion of the core component may be exposed, such that in practice up to about 20% of the surface of the fibre may be comprised of the core component. The sheath component in a fibre with an acentric

configuration will nevertheless comprise the major part of the surface of the fibre, i.e. at least about 80%. Both the cross section of the fibre and the configuration of the components will depend upon the equipment which is used in the preparation of the fibre, the process conditions and the molecular weights of the two components.

The fibres preferably have a fineness of about 1 - 7 decitex (dtex), one decitex being the weight in grams of 10 km of fibre. The length of the fibres must be taken into consideration when choosing the fineness of such fibres, and since, as explained below, the bicomponent fibres of the present invention are relatively long, the fineness should be set accordingly. The fibres will thus typically have a fineness of about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex. When more than one type of such fibres are used in the same fluff material, e.g. fibres of different length, the dtex/length ratio of the individual types of fibres may be constant or variable.

The fibres are preferably crimped, i.e. given a wavy form, in order to make them easier to process when preparing the fluff pulp. Typically, they will have about 0 to 10 crimps/cm, and preferably from about 0 to 4 crimps/cm.

The length of the bicomponent synthetic fibres of the present invention is significant, since they are substantially longer than other fibres which are typically used in the preparation of fluff. For example, natural cellulose pulp fibres, which are typically the major component in fluff, are not normally more than about 3 mm long. The thermobondable synthetic fibres currently used in the preparation of fluff are typically shorter than cellulose fibres, and the cellulose fibres therefore make up the basic structure of the material. The bicomponent synthetic fibres of the current invention are, however, substantially longer than, for example, cellulose fibres. Therefore, the high melting core component of the bicomponent fibres makes up the basic structure of the thermobonded absorbent material, giving it improved characteristics with respect to strength and dimensional stability.

The fibres of the present invention are thus cut to a length of about 3 - 24 mm, typically about 5 - 20 mm, preferably about 6 - 18 mm. Specially preferred lengths are about 6 mm and about 12 mm. The desired length is chosen according to the equipment to be used in the production of the absorbent material, as well as the nature of the material itself. While being relatively long, the fibres are nevertheless able to pass substantially intact through the grid holes in the hammer mills which are used in the production of fluff, since these holes typically have a diameter of about 10 - 18 mm, as will be described below.

The fibres may be prepared using a process comprising the following steps:

- melting the constituents of the core and sheath components.
- preferably, incorporating a surface active agent or a hydrophilic polymer or copolymer into the sheath component,
- spinning the low melting sheath component and the high melting core component into a spun bundle of bicomponent filaments, preferably by conventional melt spinning,
- stretching the spun bundle of filaments,
- preferably, crimping the fibres,
- drying and annealing the fibres, and
- cutting the fibres to the desired length.

The above steps will be described in greater detail as follows:

The constituents of the sheath and core components, respectively, are melted in separate extruders (one extruder for each of the two components), which mix the respective components such that the melts have a uniform consistency and temperature prior to spinning. The temperatures of the melted components in the extruders are well above their respective melting points, typically more than about 90°C above the melting points, thus assuring that the melts have flow properties which are appropriate for the subsequent spinning of the fibres.

To the melted sheath component is typically added the surface active agent in an appropriate amount based on the total weight of the spun fibres, as explained above. Additionally, as explained above, the sheath component may include a hydrophilic polymer or copolymer. The surface active agent or hydrophilic polymer or copolymer is important for the production of wet-processed fluff pulp, since, as explained above, it is necessary that the surface of the bicomponent synthetic fibres be made substantially hydrophilic, so that they may be distributed homogeneously in the fluff pulp. It is possible to treat the surface of the spun fibres with a wetting agent, but the result is not necessarily permanent, and thus there may be a risk that the desired hydrophilic surface properties will be lost during the production of the absorbent material. By incorporating the surface active agent or hydrophilic polymer or copolymer into the sheath component before spinning, the spun fibre is made permanently substantially hydrophilic, thus assuring that the desired homogeneous distribution of the bicomponent fibres in the fluff pulp can be obtained and that the functioning of the absorbent product will not be impaired by the presence of hydrophobic fibres.

The melted components are typically filtered prior to spinning, e.g. using a metal net, to remove any unmelted or cross-linked substances which may be present. The spinning of the fibres is typically accomplished using conventional melt spinning (also known as "long spinning"), in particular medium-speed conventional spinning, but so-called "short spinning" or "compact spinning" may also be employed (Ahmed, M., *Polypropylene Fibers - Science and Technology*, 1982). Conventional spinning involves a two-step process, in which the first step is the extrusion of the melts and the actual spinning of the fibres, while the second step is the stretching of the spun ("as-spun") fibres. Short spinning is a one-step process, in which the fibres are both spun and stretched in a single operation.

The melted sheath and core components, as obtained above, are led from their respective extruders, through a distribution system, and passed through the holes in a spinnerette. Producing bicomponent fibres is more complicated than producing monocomponent fibres, because the two components must be appropriately distributed to the

holes. Therefore, in the case of bicomponent fibres, a special type of spinnerette is used to distribute the respective components, for example a spinnerette based on the principles described in U.S. patent No. 3,584,339. The diameter of the holes in the spinnerette is typically about 0.4 - 1.2 mm, depending on the fineness of the fibres being produced. The extruded melts are then led through a quenching duct, where they are cooled by a stream of air, and at the same time drawn into bicomponent filaments, which are gathered into bundles of filaments. The bundles typically contain at least about 100 filaments, and more typically at least about 700 filaments. The spinning speed after the quenching duct is typically at least about 200 m/min, and more typically about 500 - 2000 m/min.

The bundles of filaments are subsequently stretched, preferably using so-called off-line stretching or off-line drawing, which, as mentioned above, takes place separately from the spinning process. Stretching is typically accomplished using a series of hot rollers and a hot air oven, in which a number of bundles of filaments are stretched simultaneously. The bundles of filaments pass first through one set of rollers, followed by passage through a hot air oven, and then passage through a second set of rollers. The hot rollers typically have a temperature of about 70 - 130°C, and the hot air oven typically has a temperature of about 80 - 140°C. The speed of the second set of rollers is faster than the speed of the first set, and the heated bundles of filaments are therefore stretched according to the ratio between the two speeds (called the stretch ratio or draw ratio). A second oven and a third set of rollers can also be used (two-stage stretching), with the third set of rollers having a higher speed than the second set. In this case the stretch ratio is the ratio between the speed of the last and the first set of rollers. Similarly, additional sets of rollers and ovens may be used. The fibres of the present invention are typically stretched with a stretch ratio of about 2.5:1 - 4.5:1, and preferably about 3.0:1 - 4.0:1, resulting in an appropriate fineness, i.e. about 1 - 7 dtex, typically about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex, as explained above.

The fibres are preferably crimped, typically in a so-called stuffer box, in order to make them easier to process into the fluff pulp due to a higher fiber-to-fiber friction. The bundles of filaments are led by a pair of pressure rollers into a chamber in the stuffer box, where they become crimped due to the pressure that results from the fact that they are not drawn forward inside the chamber. The degree of crimping can be controlled by the pressure of the rollers prior to the stuffer box, the pressure and temperature in the chamber and the thickness of the bundle of filaments. As an alternative, the filaments can be air-textured by passing them through a nozzle by means of a jet air stream.

The crimped fibres are then preferably annealed in order to reduce tensions which may be present after the stretching and crimping processes, and they should in addition be dried. Annealing and drying may take place simultaneously, typically by leading the bundles of filaments from the stuffer box, e.g. via a conveyer belt, through a hot-air oven. The temperature of the oven will depend on the composition of the bicomponent fibres, but must obviously be well below the melting point of the sheath component.

The annealed and dried bundles of filaments are then led to a cutter, where the fibres are cut to the desired length. Cutting is typically accomplished by passing the fibres over a wheel containing radially placed knives. The fibres are pressed against the knives by pressure from rollers, and are thus cut to the desired length, which is equal to the distance between the knives. As explained above, the fibres of the present invention are cut so as to be relatively long, i.e. about 3 - 24 mm, typically about 5 - 20 mm, preferably about 6 - 18 mm, with specially preferred lengths being about 6 mm and about 12 mm.

As mentioned above, the long thermobondable bicomponent fibre of the present invention is useful in the preparation of fluff, i.e. the fluffy fibrous material used as an absorbent core in the production of hygiene absorbent products such as disposable diapers, sanitary napkins, adult incontinence products, etc. The use of the bicomponent fibre in the preparation of fluff results in absorbent

materials with superior characteristics, including, as explained above, improved strength and dimensional stability and more efficient use of the super absorbent polymer, thus making possible the production of thinner and lighter weight products and/or products with improved absorption capacity.

A substantial portion of the fluff pulp used in the preparation of absorbent products is typically comprised of cellulose pulp fibres. As mentioned above, the fluff pulp may also contain additional fibres, e.g. thermobondable synthetic fibres. The cellulose fibres and the synthetic fibres are typically blended together at a pulp plant and subsequently formed into a so-called blend sheet, which is rolled up into a reel and transported to a converting factory, where the actual production of the fluff and the absorbent products takes place. The blend sheet is formed by a "wet-laid" process, in which a wet blend containing cellulose fibres and synthetic fibres is formed into a sheet, which is subsequently led via a conveyer belt to a drier, typically an oven, where it is dried. Fluff blends of fibres may also be produced using a dry process, in which case synthetic fibres from a bale are processed with pulp fibres at the converting factory. However, the wet process which produces the blend sheet is preferable, because the blend sheet can be fed in reel form directly into a hammer mill at the converting factory, thus making the converting process less complicated.

The absorbent material containing the long thermobondable bicomponent fibres, as described above, may be produced as follows:

- subjecting the bicomponent fibres and non-bicomponent fibres to blending, through dispersion in water, in a fluff pulp production process, so as to obtain a fluff pulp blend in which the bicomponent fibres are distributed in a substantially random and homogeneous manner,
- forming the wet blend of bicomponent and non-bicomponent fibres into a blend sheet,
- drying the blend sheet and winding it into a reel,
- defibrating the dried fluff pulp,
- forming the fluff into a mat,



- optionally, incorporating a super absorbent polymer into the fluff mat, and
- thermobonding the low melting sheath component of the bicomponent fibres in the material.

5 The non-bicomponent fibres in the fluff can comprise a variety of different types of natural and/or synthetic fibres, according to the particular absorbent material to be produced. Natural cellulose fibres for use in the preparation of the fluff will typically comprise bleached grades of CTMP (chemi-thermo-mechanical-pulp),  
10 sulphite pulp or kraft pulp.

The weight ratio of the bicomponent fibres to the non-bicomponent fibres in the fluff is preferably in the range of about 1:99 - 80:20. It is necessary that the fluff contain a certain minimum amount of the bicomponent fibres in order that the improved characteristics due  
15 to the supporting structure of the thermobonded bicomponent fibres can be achieved. Thus, a bicomponent fibre content of about 1% is regarded as being the necessary minimum. On the other hand, the bicomponent fibres of the present invention need not necessarily constitute a large portion of the fluff. In fact, one of the  
20 advantages of these fibres is that they can be used in a reduced amount, compared to the amount typically used in products comprising other currently available thermobondable synthetic fibres. The weight ratio of the bicomponent fibres to the non-bicomponent fibres in the fluff will therefore typically be about 3:97 - 50:50,  
25 preferably about 5:95 - 20:80, more preferably about 5:95 - 15:85, and especially about 5:95 - 8:92.

The bicomponent fibres, having preferably been made permanently substantially hydrophilic, can easily be distributed in a random and substantially homogeneous manner in the wet fluff pulp, as explained  
30 above.

It is possible that during the wet process in which the fluff pulp is mixed, a certain amount of the surface active agent may in certain cases be removed from the surface of the bicomponent synthetic fibres. However, it is not believed that this will result in a

permanent reduction of the hydrophilic properties of the fibres, since it is believed that the surface active agent, which is also present in the interior of the sheath component of the fibres, will subsequently migrate outwards to the surface of the fibres within a short time, typically within about 24 hours, thereby restoring the fibres' hydrophilic properties.

The wet fluff pulp is then transferred to a mesh, forming a blend sheet, which is led to a drier, typically an oven, and dried, using a temperature that is significantly below the melting point of the sheath component of the bicomponent fibres. The blend sheet is typically dried to a water content of about 6 - 9%. The blend sheet, which typically weighs about 550 - 750 g/m<sup>2</sup>, and more typically about 650 g/m<sup>2</sup>, is then rolled up, and the reel is then normally transported to the converting factory, where the remaining steps in the production of the absorbent material typically take place.

At the converting factory, the fluff pulp from the reel is typically led to a hammer mill (as illustrated in Fig. 4), for example via a pair of feeding rollers, where the fluff pulp is defibrated. However, defibration may also be accomplished by other methods, for example by using a spike mill, saw-tooth mill or disc refiner. The hammer mill housing encases a series of hammers which are fixed to a rotor. The rotor typically has a diameter of, for example, 800 mm, and typically revolves at a speed of, for example, 3000 rpm. The hammer mill is typically driven by a motor with a power of, for example, 100 kW. Defibration is accomplished as the fibres of the fluff pulp are expelled through the grid holes in the hammer mill. The size of the grid holes depends on the type of fluff being produced, but they will typically be about 10 to 18 mm in diameter. The bicomponent fibres should have a length which is compatible with the size of the grid holes, so that the fibres will survive the defibration in the hammer mill substantially intact. This means that the fibres should not be substantially longer than the diameter of the grid holes.

The defibrated fluff is then formed into a fluff mat in a fluff mat forming hood by suction onto a wire mesh, typically followed by

passage through a series of condensing or embossing rollers. The mat is preferably compressed (i.e. either condensed or embossed), but it may also be non-compressed, according to how the absorbent material is to be used. Compression of the mat can alternatively take place  
5 either during or after thermobonding.

Prior to thermobonding, a super absorbent polymer, in the form of a powder or small particles, is often incorporated into the material, typically by spraying it into the fluff mat from a nozzle located in the fluff mat forming hood. The purpose of using a super absorbent  
10 polymer is to achieve a reduction in the weight and size of the absorbent product, as the amount of fluff in the product can be reduced. The type of super absorbent polymer used is not critical, but it is typically a chemically crosslinked polyacrylic acid salt, preferably a sodium salt or sodium ammonium salt. Such super  
15 absorbents are typically able to absorb about 60 times their own weight in urine, blood or other body fluids, or about 200 times their own weight in pure water. They also have the additional advantage that they form a gel upon wetting, thus enabling the absorbent product to more effectively retain the absorbed liquid under  
20 pressure. As explained above, the super absorbent polymer is fixed in the desired position in the absorbent material, due to the stable matrix structure formed by the bicomponent fibres upon thermobonding. A more efficient use of the super absorbent polymer is thus achieved, and conglomerations of the super absorbent, which can lead to  
25 barriers caused by the gel which forms upon wetting and swelling, are avoided.

One gram of super absorbent polymer can typically replace about five grams of pulp fibre (e.g. cellulose fibre) in the absorbent material. The super absorbent polymer is typically incorporated in the amount  
30 of about 10 to 70%, preferably about 12 to 40%, more preferably about 12 to 20%, and especially about 15%, based on the weight of the material.

Subsequent to the incorporation of the super absorbent polymer, the mat is thermobonded, e.g. using an air-through oven, infrared heating  
35 or ultrasonic bonding, such that the low melting component of the

- bicomponent fibres melts and fuses with other bicomponent fibres and at least some of the non-bicomponent fibres, while the high melting component of the bicomponent fibres remains substantially intact, forming a supporting three-dimensional matrix in the absorbent material (as illustrated in Fig. 3). In addition to giving the absorbent material the improved characteristics which have already been discussed, this matrix structure also makes it possible to thermoform the absorbent products, for example to obtain channels for liquid distribution or to give the products an anatomical shape.
- 10 The thermobonded absorbent material is then typically formed into units suitable for use in the production of hygiene absorbent products such as disposable diapers, sanitary napkins and adult incontinence products, e.g. by water jet cutting. Alternatively, the absorbent material may be formed into such individual units prior to thermobonding. The residual material (outcuts) may subsequently be led back to the hammer mill to be reused in the preparation of fluff.

The present invention will be more fully described in the following, with reference to the accompanying drawings.

- 20 Fig. 1 shows bicomponent fibres in which the components are arranged in a concentric (a) and an acentric (b) configuration. Fig. 2 shows the long bicomponent fibres and the other fibres in the fluff prior to thermobonding. Fig. 3 shows the matrix structure formed by the bicomponent fibres after thermobonding. 25 Fig. 4 shows the hammer mill and equipment for producing the absorbent material.

- Fig. 1a shows a cross-section of a bicomponent fibre 8 with a concentric configuration. A core component 10 is surrounded by a sheath component 12 with a substantially uniform thickness, resulting in a bicomponent fibre in which the core component 10 is substantially centrally located. 30

Fig. 1b shows a cross-section of a bicomponent fibre 14 with an  
acentric configuration. A core component 16 is substantially  
surrounded by a sheath component 18 with a varying thickness,  
resulting in a bicomponent fibre in which the core component 16 is  
5 not centrally located.

Fig. 2 shows the structure of the fluff prior to thermobonding.  
Bicomponent fibres 20 according to the present invention, comprising  
a low melting sheath component and a high melting core component, are  
arranged in a substantially random and homogeneous manner among non-  
10 bicomponent fibres 22 in the fluff.

Fig. 3 shows the same structure as illustrated in Fig. 2 after  
thermobonding. The sheath component of the bicomponent fibres has  
been melted by the thermobonding process, fusing the intact core  
components together 24, thus forming a supporting three-dimensional  
15 matrix. The non-bicomponent fibres 22 are randomly arranged in the  
spaces defined by the bicomponent fibres. Some of the non-  
bicomponent fibres 22 have been fused 26 to the bicomponent fibres.

In Fig. 4, fluff pulp 30 from a reel 32 is moistened by water sprayed  
from a nozzle 34 while being led to a hammer mill 36. The moistened  
20 fluff pulp is introduced to the hammer mill 36 via feeding rollers  
38. The fluff pulp 30 comprises a mixture of the bicomponent fibres  
of the present invention and other non-bicomponent fibres. The  
hammer mill 36 includes a hammer mill housing 40, primary air inlets  
42 and a secondary air inlet 44, hammers 46 fixed to a rotor 48, a  
25 grid 50 and an outlet 52 for defibrated material 54. A fan 56 leads  
the defibrated material 54 to a fluff mat forming hood 62 via an  
exhaust outlet 60. A super absorbent polymer powder is distributed  
in the fluff mat 63 via a nozzle 61. The fluff mat 63 is led from a  
wire mesh 64 through condensing or embossing rollers 66 to another  
30 wire mesh 72, where the bicomponent fibres are thermobonded by heat  
treatment in an through-air oven 68, in which hot air is drawn  
through the material with the aid of a suction box 70. A converting  
machine 74 is used for the production of hygienic absorbent products  
from the thermobonded material.

The fluff pulp reel 32, comprising, as explained above, a dried blend of the bicomponent fibres of the present invention and non-bicomponent fibres, is prepared in a pulp plant and transported to a converting factory, where the process illustrated in Fig. 4 takes place. Prior to processing in the hammer mill, the fluff pulp is moistened by a water spray in order to eliminate electrostatic buildup. The fluff pulp reel 32, as obtained from the pulp plant, typically has a diameter of, for example, 1000 mm, a width of, for example, 500 mm and a moisture content of about 6 - 9%, and the weight of the sheet is typically about 650 g/m<sup>2</sup>. The fluff pulp is defibrated in the hammer mill 36, in which the rotating hammers 46 expel the fluff through the holes in the grid 50. The rotor 48 which holds the hammers 46 typically has a diameter of, for example, 800 mm and rotates at the rate of, for example, 3000 rpm, driven by a motor with a power of, for example, 100 kW. The grid 50, which is made from a metal sheet with a thickness of about 3 mm, contains holes with a diameter of about 10 - 18 mm. The length of the bicomponent fibres in the fluff pulp 30 is not substantially greater than the diameter of the holes in the grid 50, so that the bicomponent fibres, as well as the shorter non-bicomponent fibres, are able to pass through the grid 50 holes substantially intact. The defibrated material 54 is then led, with the aid of the fan 56, through the exhaust outlet 60 to the fluff mat forming hood 62, where a fluff mat 63 is formed by suction of the defibrated material 54 onto a wire mesh 64. A super absorbent polymer powder is typically sprayed from a nozzle 61 when half of the fluff mat 63 is formed, so that the super absorbent polymer powder lies substantially in the centre of the fluff mat 63. The fluff mat 63 typically passes through a series of rollers 66, in which the mat 63 is condensed or embossed prior to the thermobonding process. The mat 63 is then led via the second wire mesh 72 past the through-air oven 68, which thermobonds the material, thus producing the supporting structure formed by the core component of the bicomponent fibres, as shown in Fig. 3. The thermobonded material is then led to the converting machine 74, in which the production of hygiene absorbent products, such as diapers, takes place.

The invention is further illustrated by the following non-limiting examples.

#### EXAMPLE 1

Preparation of a permanently hydrophilic, thermobondable, bicomponent synthetic fibre

Preparation of the fibre comprised the following steps:

- incorporating a surface active agent into the polyethylene sheath component,
- subjecting the two components of the fibre to a sheath-and-core type conventional melt spinning, resulting in an as-spun bundle of filaments,
- stretching the as-spun bundle of filaments,
- crimping the stretched bundle of filaments,
- annealing and drying the stretched bundle of filaments, and
- cutting the fibres.

The sheath component of the bicomponent fibre consisted of polyethylene (LLDPE - linear low density polyethylene, octene-based) with a melting point of 125°C and a density of 0.940 g/cm<sup>3</sup>, while the core component consisted of isotactic polypropylene with a melting point of 160°C. A surface active agent was incorporated into the polyethylene component before spinning by mixing it into the melted polyethylene, thus making the bicomponent fibres permanently hydrophilic, with hydrophilicity being defined as a sinkage time in water of not more than 5 seconds. The surface active agent (Atmer® 685 from ICI, a proprietary non-ionic surfactant blend) was incorporated in the amount of 1%, based on the total weight of the bicomponent fibres, this being the equivalent of 2% of the weight of the polyethylene component, since the ratio of polyethylene to polypropylene in the bicomponent fibres was 50/50. Atmer® 685 is a blend comprising 20% surfactant and 80% polyethylene, with an HLB (hydrophilic-lipophilic balance) value of 5.6 and a viscosity at 25°C of 170 mPa s.

The polyethylene component was extruded at a temperature of 245°C and a pressure of 35 bars, while the polypropylene component was extruded at a temperature of 320°C and a pressure of 55 bars. The two components were subsequently subjected to a sheath-and-core type conventional melt spinning, using a spinning speed of 820 m/min, resulting in an "as-spun" bundle of bicomponent filaments.

Off-line stretching of the filaments was carried out in a two-stage drawing operation, using a combination of hot rollers and a hot air oven, both of which had a temperature of 110°C, with a stretch ratio of 3.6:1. The stretched filaments were then crimped in a stuffer-box crimper. The filaments were annealed in an oven, at a temperature of 115°C, in order to reduce contraction of the fibre during the preparation of absorbent material, and also to obtain a reduction in the fibre's water content (to about 5 - 10%), and subsequently cut.

The finished bicomponent fibres had a length of about 12 mm, a fineness of about 1.7 - 2.2 dtex and about 2 - 4 crimps/cm.

## EXAMPLE 2

Preparation of an absorbent material using CTMP fibres and long hydrophilic thermobondable bicomponent synthetic fibres

The preparation of the absorbent material comprised the following steps:

- mixing CTMP fibres and the bicomponent fibres of the present invention during the wet stage of a fluff pulp production process,
- drying the fluff pulp,
- defibrating the fluff pulp,
- forming the fluff into a fluff cake, and
- thermobonding the low melting sheath component of the bicomponent fibres.

In a laboratory hydropulper (British disintegrator), bicomponent synthetic fibres (polypropylene core/polyethylene sheath) were



blended with CTMP (chemi-thermo-mechanical-pulp) fluff pulp fibres in a ratio of 6%:94% (3 g bicomponent fibres, 47 g CTMP fibres). The bicomponent fibres had a cut length of 12 mm, a fineness of about 1.7 - 2.2 dtex, and about 2 - 4 crimps/cm, and were prepared as in  
5 Example 1. The CTMP fibres had a length of about 1.8 mm, and a thickness of about 10 - 70  $\mu\text{m}$  (average:  $30 \pm 10 \mu\text{m}$ ). CTMP fibres are produced in a combined chemical and mechanical refining process (as opposed to other pulp fibres which are subjected to a chemical treatment only). The bicomponent fibres, which included a surface  
10 active agent that had been incorporated into the polyethylene sheath component, as described in Example 1, were hydrophilic, and therefore easily dispersed in the wet fluff pulp.

Drying of the fluff pulp was carried out in a drying drum at a temperature of 60°C, which is well below the melting point of the  
15 low melting component of the bicomponent fibres, for a period of 4 hours. The dried fluff pulp (water content 6 - 9%) weighed 750 g/m<sup>2</sup>. In order to eliminate electrostatic buildup, the dried fluff pulp was conditioned overnight at 50% relative humidity and a temperature of 23°C.

20 Defibration was carried out in a laboratory hammer mill (Type H-01 Laboratory Defibrator, Kamas Industri AB, Sweden) with a 1.12 kW motor, with hammers fixed to a rotor with a diameter of 220 mm which revolved at a speed of about 4500 rpm, and with grid holes with a diameter of 12 mm in a 2 mm thick metal sheet. The fluff was fed  
25 into the hammer mill at a rate of 3.5 g/s. The bicomponent and CTMP fibres, neither of which were more than 12 mm long, were both able to pass substantially intact through the grid holes in the hammer mill. The defibration process required an energy consumption of 117 MJ/ton for the blend of CTMP + 6% bicomponent fibres, while defibration of  
30 CTMP fluff alone required 98 MJ/ton.

The defibrated blend was then formed into a fluff cake with the aid of standard laboratory pad-forming equipment.

The fluff was subsequently thermobonded by treatment in a laboratory hot-air oven at a temperature range of 110 - 130°C (as measured from

the air flow immediately after passage through the sample), for a period of 5 sec. During the thermobonding process, the low melting sheath component of the bicomponent fibres melted and fused with other bicomponent fibres and some of the CTMP fibres, while the high melting component of the bicomponent fibres remained intact. The high melting component of the bicomponent fibres formed a supporting three-dimensional matrix in the absorbent material, giving it improved pad integrity (network strength) and shape retention characteristics. The results of measurements of pad integrity are shown in Table 1. The test pad, which was formed in a SCAN-C 33 standard test-piece former, weighed 1 g and had a diameter of 50 mm. The test was performed with an Instron tensile tester with a PFI measuring apparatus.

Table 1. Pad integrity.

		Non-thermobonded	Thermobonded
Dry	CTMP	4,4 N	5,3 N
	+ 6% bicomponent fibres	5,0 N	14,0 N
Wet	CTMP	4,4 N	4,3 N
	+ 6% bicomponent fibres	5,5 N	9,1 N

### EXAMPLE 3

Various permanently hydrophilic, thermobondable, bicomponent synthetic fibres were prepared, using substantially the same process as in Example 1. The core component of the fibres consisted of polypropylene as described in Example 1, and the weight ratio of the sheath/core components in the fibres was 50:50. The surface active agent was the same as that employed in Example 1, and was used in the same amount of 1% based on the total weight of the bicomponent fibres. The other characteristics of the fibres were as follows:

Sheath					
No.	Composition	Length	Crimping	Fineness	
5	1	LLDPE	6 mm	crimped	2.2 dtex
	2	LLDPE	12 mm	crimped	2.2 dtex
	3	LLDPE	18 mm	crimped	2.2 dtex
	4	LLDPE	6 mm	uncrimped	2.2 dtex
	5	75% LLDPE 25% EVA*	12 mm	uncrimped	3.3 dtex
10	* EVA - Ethyl vinyl acetate				

## EXAMPLE 4

Laboratory tests on test pads comprising various bicomponent synthetic fibres

Fluff samples were prepared following substantially the procedure of Example 2, using the fibres described in Example 3 as the bicomponent synthetic fibres. Fluff samples were prepared comprising 94% by weight of Scandinavian spruce CTMP pulp and 6% by weight of the respective synthetic fibres. In addition, samples containing 3%, 4.5%, 9% and 12% (by weight) of the synthetic fibre were prepared with fibres 1 and 2. As a reference sample, fluff samples were prepared using 100% CTMP pulp.

Blendsheets were prepared by first blending the CTMP fibres and the synthetic fibres in water in a British disintegrator as in Example 2. The blendsheets were subsequently wet pressed to a constant thickness (bulk - 1.5 cm<sup>3</sup>/g) and dried on a drying drum at a temperature of 60°C. There were no difficulties in the preparation of the blendsheets, even with the longest synthetic fibres. The blendsheets were then defibrated in a Kamas H-101 hammer mill as in Example 2, using a 12 mm screen and a rotation speed of 4500 rpm.

The knot content of the fluff was determined using a SCAN-C 38 knot tester. The longest fibres (sample 3) had a tendency to form bundles in the knot tester, so that the test could not be completed in this case. It was found that the knot content of fluff containing 6% synthetic fibres having a length of 6 mm (samples 1 and 4) was only 1%, while the knot content of fluff containing 6% synthetic fibres having a length of 12 mm (samples 2 and 5) was somewhat higher, 4% and 7%, respectively.

Test pads having a weight of 1 g were formed using a SCAN pad forming apparatus.

Thermobonding was carried out at a temperature of 170°C, as this temperature was found to be suitable in preliminary tests. Heating times of 1, 2 and 4 seconds were initially tested. The 1 second heating time gave the best overall result, and this time was used for the final tests.

The pad integrity of the test pads was measured as described in Example 2. The results of these measurements are given in Table 2 below, in which the values for network strength are averages based on 10 samples.

Table 2. Comparison of test pads prepared with various synthetic fibres

5	Network Strength (N)					
	Before Thermo-		After Thermo-			
	bonding		bonding			
	Synthetic					
Sample	Fibre %	Dry	Wet	Dry	Wet	
CTMP	0	3.6	5.0	3.7	5.8	
10	1	3.0	3.1	5.7	8.6	6.5
	1	4.5	3.3	5.7	10.5	7.8
	1	6.0	3.1	5.6	14.0	8.7
	1	9.0	3.5	5.6	13.2	9.4
	1	12.0	3.4	5.7	20.0	11.8
15	2	3.0	3.7	6.5	10.8	7.6
	2	4.5	3.6	6.3	11.4	8.8
	2	6.0	3.7	6.3	12.0	8.9
	2	9.0	3.8	6.1	13.8	10.1
	2	12.0	3.8	6.5	20.0	10.8
20	3	6.0	3.5	5.3	10.4	8.7
	4	6.0	2.9	5.3	10.2	8.0
	5	6.0	3.1	5.1	9.9	7.4

It can be seen from the above table that the dry network strength increased greatly after thermobonding as a result of the incorporation of the bicomponent synthetic fibres according to the invention. Samples 1 and 2 tended to have a slightly better performance in this respect than the others. A comparison of the results for sample 1 (6%) with those for sample 4 shows that crimped fibres are better than uncrimped fibres.

The wet network strength of the test pads was also increased by the incorporation of the synthetic fibres, but the increase was not as great as that of the dry network strength. Samples 1 and 2 tended to provide an improvement in the wet network strength even before thermobonding.

It was thus shown that the incorporation of relatively small amounts of the synthetic bicomponent fibres of the invention provides a considerable increase in the strength of the absorbent pads after thermobonding, as compared to similar pads without the synthetic fibres.

#### EXAMPLE 5

Bicomponent synthetic fibres according to the invention were prepared as fibres 1 and 2 of Example 3, with the exception that they had a fineness of 1.7 dtex. The fibres were used to prepare test pads in which the cellulose fibres consisted of either Scandinavian spruce CTMP pulp (fluff grade) or bleached, untreated Scandinavian kraft pulp (Stora Fluff UD 14320), using the same procedure as in Example 4. Reference samples containing either 100% CTMP or 100% kraft pulp were also prepared.

The network strength of the test pads was measured as described above. The results are given in Table 3 below, in which the values for network strength are averages based on 10 samples.

Table 3. Comparison of test pads with different pulp types and synthetic fibres of different lengths

5	Pulp Blend	Synthetic fibre Length	Synthetic fibre %	Network Strength (N)			
				Before Thermo-bonding		After Thermo-bonding	
				Dry	Wet	Dry	Wet
10	CTMP	-	0	3.4	5.2	4.4	5.1
	CTMP	6 mm	3.0	3.6	5.8	7.8	5.3
			4.5	3.7	5.5	9.3	6.5
			6.0	3.8	5.8	11.6	6.3
			9.0	3.5	6.1	11.4	8.2
15			12.0	3.7	6.0	20.0	9.8
	CTMP	12 mm	3.0	4.1	5.2	9.4	7.1
			4.5	3.8	5.9	9.7	8.4
			6.0	4.2	6.2	10.7	7.6
			9.0	4.0	6.0	12.3	8.9
20			12.0	3.7	6.4	20.0	10.2
	Kraft	-	3.0	4.9	5.6	5.8	5.5
	Kraft	6 mm	3.0	5.2	6.0	9.1	7.9
			4.5	5.2	5.9	10.4	8.7
			6.0	5.5	5.8	10.2	8.6
25			9.0	5.7	6.2	13.2	8.5
			12.0	5.2	6.2	20.0	11.2
	Kraft	12 mm	3.0	5.8	6.6	9.9	8.6
			4.5	5.8	6.9	9.9	8.6
			6.0	5.6	6.8	10.0	8.3
30			9.0	5.4	6.6	17.0	9.4
			12.0	5.4	6.5	20.0	11.3

The dry network strength of the kraft test pads was higher than that of the CTMP samples before thermobonding. However, the values were nearly the same after thermobonding. The network strength after thermobonding was significantly increased by incorporation of even small amounts of the synthetic fibres, and was approximately doubled by the addition of 6% synthetic fibres, as compared to the reference test pads comprising only CTMP or kraft pulp fibres.

The wet network strength of the kraft test pads was somewhat higher than that of the CTMP test pads both before and after thermobonding. Both the 12 mm and 6 mm synthetic fibres gave an improvement in wet network strength in both CTMP and kraft pulp pads after thermobonding. The difference in wet strength between pads having synthetic fibre levels of between 3 and 9% was rather small in all cases.

By comparing the results of the measurements of network strength for the CTMP pads in this example with the results from samples 1 and 2 in Example 4 above, it can be seen that a somewhat higher network strength was achieved in most cases by using the slightly thicker synthetic fibres of Example 4, which had a fineness of 2.2 dtex.



## CLAIMS

1. A thermobondable bicomponent synthetic fibre with a length of at least about 3 mm, adapted to use in the blending of fluff pulp, comprising an inner core component and an outer sheath component, in  
5 which
  - the core component comprises a polyolefin or a polyester,
  - the sheath component comprises a polyolefin, and
  - the core component has a higher melting point than the sheath component.
- 10 2. A bicomponent synthetic fibre according to claim 1 which has been made permanently substantially hydrophilic by the incorporation into the sheath component of a surface active agent, e.g. a fatty acid ester of glycerides, a fatty acid amide, a polyglycol ester, a polyethoxylated amide, a nonionic surfactant, a cationic surfactant,  
15 or a blend of the above and/or other compounds normally used as emulsifiers, surfactants or detergents.
3. A bicomponent synthetic fibre according to claim 2 in which the surface active agent has been incorporated into the sheath component in the amount of about 0.1 - 5 %, and preferably about 0.5 - 2%,  
20 based on the total weight of the fibre.
4. A bicomponent synthetic fibre according to claim 2 or 3 in which the sheath component includes an (ethyl vinyl acetate) or (ethylene acrylic acid) copolymer, or another hydrophilic copolymer or hydrophilic polymer.
- 25 5. A bicomponent synthetic fibre according to claim 4 which includes about 0.1 - 5%, and preferably about 0.5 - 2% vinyl acetate or acrylic acid, based on the total weight of the fibre.
6. A bicomponent synthetic fibre according to any of claims 1 to 5 in which the melting point of the core component is at least 150°C  
30 and that of the sheath component is 140°C or lower.

7. A bicomponent synthetic fibre according to any of claims 1 to 5 in which the melting point of the core component is at least 210°C and that of the sheath component is 170°C or lower.
8. A bicomponent synthetic fibre according to any of claims 1 to 7 in which the sheath component comprises a polyolefin, e.g. high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, poly(1-butene), or copolymers or mixtures of the foregoing.
9. A bicomponent synthetic fibre according to any of claims 1 to 8 in which the core component comprises a high melting polyolefin, e.g. polypropylene or poly(4-methyl-1-pentene), or a polyester, e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate), or copolymers or mixtures of the foregoing.
10. A bicomponent synthetic fibre according to any of claims 1 to 9 in which the core (a) and sheath (b) components, respectively, comprise
- (a) polypropylene and (b) either high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene), or
  - (a) poly(4-methyl-1-pentene) or a polyester (e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate)) and (b) either polypropylene, high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene).
11. A bicomponent synthetic fibre according to any of claims 1 to 10 in which the weight distribution of the sheath/core components is from about 10:90 to 90:10, typically from about 30:70 to 70:30, and preferably from about 40:60 to 65:35.
12. A bicomponent synthetic fibre according to any of claims 1 to 11 which has a length of about 3 - 24 mm, typically about 5 - 20 mm, preferably about 6 - 18 mm.

13. A bicomponent synthetic fibre according to claim 12 which has a length of about 6 mm.
14. A bicomponent synthetic fibre according to claim 12 which has a length of about 12 mm.
- 5 15. A bicomponent synthetic fibre according to any of claims 1 to 14 with a fineness of about 1 - 7 dtex, typically about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex.
- 10 16. A bicomponent synthetic fibre according to any of claims 1 to 15 which has been texturized to a level of from about 0 to 10 crimps/cm, preferably from about 0 to 4 crimps/cm.
17. A bicomponent synthetic fibre according to any of claims 1 to 16 which has a circular, oval or irregular cross-section, and preferably a circular cross-section.
- 15 18. A bicomponent synthetic fibre according to any of claims 1 to 17 in which the two components are arranged in a concentric or acentric configuration.
19. A process for producing thermobondable sheath-and-core type bicomponent synthetic fibres adapted to use in the blending of fluff pulp, the fibres having a length of at least about 3 mm and having a sheath component comprising a polyolefin and a core component comprising a polyolefin or a polyester, which comprises
- 20
- melting the constituents of the core and sheath components,
  - preferably, incorporating a surface active agent or a

25

  - hydrophilic polymer or copolymer into the sheath component,
  - spinning the low melting sheath component and the high melting core component into a spun bundle of bicomponent filaments,
  - stretching the bundle of filaments,
  - preferably, crimping the fibres,

30

  - drying and fixing the fibres, and
  - cutting the fibres to the desired length.

20. A process according to claim 19 in which the fibres are made permanently substantially hydrophilic by the incorporation into the sheath component of a surface active agent, e.g. a fatty acid ester of glycerides, a fatty acid amide, a polyglycol ester, a polyethoxylated amide, a nonionic surfactant, a cationic surfactant, or a blend of the above and/or other compounds normally used as emulsifiers, surfactants or detergents.
21. A process according to claim 20 in which the surface active agent is incorporated into the sheath component in the amount of about 0.1 - 5 %, and preferably about 0.5 - 2%, based on the total weight of the fibre.
22. A process according to claim 20 or 21 in which the sheath component of the fibres includes an (ethyl vinyl acetate) or (ethylene acrylic acid) copolymer, or another hydrophilic copolymer or polymer.
23. A process according to claim 22 in which the fibres include about 0.1 - 5%, and preferably about 0.5 - 2% vinyl acetate or acrylic acid, based on the total weight of the fibre.
24. A process according to any of claims 19 to 23 in which the melting point of the core component is at least 150°C and that of the sheath component is 140°C or lower.
25. A process according to any of claims 19 to 23 in which the melting point of the core component is at least 210°C and that of the sheath component is 170°C or lower.
26. A process according to any of claims 19 to 25 in which the sheath component comprises a polyolefin, e.g. high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, poly(1-butene), or copolymers or mixtures of the foregoing.

27. A process according to any of claims 19 to 26 in which the core component comprises a high melting polyolefin, e.g. polypropylene or poly(4-methyl-1-pentene), or a polyester, e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-

5 cyclohexylene-dimethylene-terephthalate), or copolymers or mixtures of the foregoing.

28. A process according to any of claims 19 to 27 in which the core (a) and sheath (b) components, respectively, comprise

10 - (a) polypropylene and (b) either high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene), or

15 - (a) poly(4-methyl-1-pentene) or a polyester (e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate)) and (b) either polypropylene, high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene or poly(1-butene).

29. A process according to any of claims 19 to 28 in which the weight distribution of the sheath/core components is from about 10:90  
20 to 90:10, typically from about 30:70 to 70:30, and preferably from about 40:60 to 65:35.

30. A process according to any of claims 19 to 29 in which the filaments are spun using either conventional melt spinning or short spinning, but preferably conventional melt spinning.

25 31. A process according to any of claims 19 to 30 in which the fibres have a circular, oval or irregular cross-section, and preferably a circular cross-section.

32. A process according to any of claims 19 to 31 in which the two components are arranged in a concentric or acentric configuration.

30 33. A process according to any of claims 19 to 32 in which the bundle of filaments is stretched using an off-line stretching process.

34. A process according to any of claims 19 to 33 in which the stretch ratio is about 2.5:1 - 4.5:1, and preferably about 3.0:1 - 4.0:1.
- 5 35. A process according to any of claims 19 to 34 in which the fibres are stretched to a fineness of about 1 - 7 dtex, typically about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex.
- 10 36. A process according to any of claims 19 to 35 in which the fibres are texturized to a level of about 0 - 10 crimps/cm, and preferably about 0 - 4 crimps/cm.
37. A process according to any of claims 19 to 36 in which the fibres are cut to a length of about 3 - 24 mm, typically about 5 - 20 mm, preferably about 6 - 18 mm.
- 15 38. A process according to claim 37 in which the fibres are cut to a length of about 6 mm.
39. A process according to claim 37 in which the fibres are cut to a length of about 12 mm.

Received by the International Bureau  
on 15 September 1989 (15.09.89);  
original claims 1 and 2 replaced by amended claim 1; claims  
3-18 renumbered as claims 2-17; claims 19 and 20 replaced by amended claim  
18; claims 21-39 renumbered as claims 19-37 (6 pages)]

1. A thermobondable bicomponent synthetic fibre with a length of at  
least about 3 mm, adapted to use in the blending of fluff pulp,  
comprising an inner core component and an outer sheath component, in  
5 which

- the core component comprises a polyolefin or a polyester,
- the sheath component comprises a polyolefin, and
- the core component has a higher melting point than the  
sheath component,

10 the fibre being permanently substantially hydrophilic due to the  
incorporation into the sheath component of a surface active agent,  
e.g. a fatty acid ester of glycerides, a fatty acid amide, a  
polyglycol ester, a polyethoxylated amide, a nonionic surfactant, a  
cationic surfactant, or a blend of the above and/or other compounds  
15 normally used as emulsifiers, surfactants or detergents.

2. A bicomponent synthetic fibre according to claim 1 in which the  
surface active agent has been incorporated into the sheath component  
in the amount of about 0.1 - 5 %, and preferably about 0.5 - 2%,  
based on the total weight of the fibre.

20 3. A bicomponent synthetic fibre according to claim 1 or 2 in which  
the sheath component includes an (ethyl vinyl acetate) or (ethylene  
acrylic acid) copolymer, or another hydrophilic copolymer or  
hydrophilic polymer.

4. A bicomponent synthetic fibre according to claim 3 which includes  
25 about 0.1 - 5%, and preferably about 0.5 - 2% vinyl acetate or  
acrylic acid, based on the total weight of the fibre.

5. A bicomponent synthetic fibre according to any of claims 1 to 4  
in which the melting point of the core component is at least 150°C  
and that of the sheath component is 140°C or lower.

30 6. A bicomponent synthetic fibre according to any of claims 1 to 4 in

which the melting point of the core component is at least 210°C and that of the sheath component is 170°C or lower.

7. A bicomponent synthetic fibre according to any of claims 1 to 6 in which the sheath component comprises a polyolefin, e.g. high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, poly(1-butene), or copolymers or mixtures of the foregoing.

8. A bicomponent synthetic fibre according to any of claims 1 to 7 in which the core component comprises a high melting polyolefin, e.g. polypropylene or poly(4-methyl-1-pentene), or a polyester, e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate), or copolymers or mixtures of the foregoing.

9. A bicomponent synthetic fibre according to any of claims 1 to 8 in which the core (a) and sheath (b) components, respectively, comprise

- (a) polypropylene and (b) either high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene), or
- (a) poly(4-methyl-1-pentene) or a polyester (e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate)) and (b) either polypropylene, high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene).

10. A bicomponent synthetic fibre according to any of claims 1 to 9 in which the weight distribution of the sheath/core components is from about 10:90 to 90:10, typically from about 30:70 to 70:30, and preferably from about 40:60 to 65:35.

11. A bicomponent synthetic fibre according to any of claims 1 to 10 which has a length of about 3 - 24 mm, typically about 5 - 20 mm, preferably about 6 - 18 mm.



12. A bicomponent synthetic fibre according to claim 11 which has a length of about 6 mm.
13. A bicomponent synthetic fibre according to claim 11 which has a length of about 12 mm.
- 5 14. A bicomponent synthetic fibre according to any of claims 1 to 13 with a fineness of about 1 - 7 dtex, typically about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex.
- 10 15. A bicomponent synthetic fibre according to any of claims 1 to 14 which has been texturized to a level of from about 0 to 10 crimps/cm, preferably from about 0 to 4 crimps/cm.
16. A bicomponent synthetic fibre according to any of claims 1 to 15 which has a circular, oval or irregular cross-section, and preferably a circular cross-section.
- 15 17. A bicomponent synthetic fibre according to any of claims 1 to 16 in which the two components are arranged in a concentric or acentric configuration.
18. A process for producing thermobondable sheath-and-core type bicomponent synthetic fibres adapted to use in the blending of fluff pulp, the fibres having a length of at least about 3 mm and having a sheath component comprising a polyolefin and a core component comprising a polyolefin or a polyester, which comprises
- 20
- melting the constituents of the core and sheath components.
  - incorporating a surface active agent, e.g. a fatty acid ester of glycerides, a fatty acid amide, a polyglycol ester, a polyethoxylated amide, a nonionic surfactant, a cationic surfactant, or a blend of the above and/or other compounds normally used as emulsifiers, surfactants or detergents, into the sheath component,
- 25
- spinning the low melting sheath component and the high melting core component into a spun bundle of bicomponent filaments,
- 30

- stretching the bundle of filaments,
- preferably, crimping the fibres,
- drying and fixing the fibres, and
- cutting the fibres to the desired length.

- 5 19. A process according to claim 18 in which the surface active agent is incorporated into the sheath component in the amount of about 0.1 - 5 %, and preferably about 0.5 - 2%, based on the total weight of the fibre.
- 10 20. A process according to claim 18 or 19 in which the sheath component of the fibres includes an (ethyl vinyl acetate) or (ethylenic acrylic acid) copolymer, or another hydrophilic copolymer or polymer.
- 15 21. A process according to claim 20 in which the fibres include about 0.1 - 5%, and preferably about 0.5 - 2% vinyl acetate or acrylic acid, based on the total weight of the fibre.
22. A process according to any of claims 18 to 21 in which the melting point of the core component is at least 150°C and that of the sheath component is 140°C or lower.
- 20 23. A process according to any of claims 18 to 21 in which the melting point of the core component is at least 210°C and that of the sheath component is 170°C or lower.
- 25 24. A process according to any of claims 18 to 23 in which the sheath component comprises a polyolefin, e.g. high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, poly(1-butene), or copolymers or mixtures of the foregoing.
- 30 25. A process according to any of claims 18 to 24 in which the core component comprises a high melting polyolefin, e.g. polypropylene or poly(4-methyl-1-pentene), or a polyester, e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-

cyclohexylene-dimethylene-terephthalate), or copolymers or mixtures of the foregoing.

26. A process according to any of claims 18 to 25 in which the core (a) and sheath (b) components, respectively, comprise

- 5       - (a) polypropylene and (b) either high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene, or poly(1-butene), or
- 10       - (a) poly(4-methyl-1-pentene) or a polyester (e.g. poly(ethylene-terephthalate), poly(butylene-terephthalate) or poly(1,4-cyclohexylene-dimethylene-terephthalate)) and (b) either polypropylene, high density polyethylene, low density polyethylene, linear low density polyethylene, polypropylene or poly(1-butene).

27. A process according to any of claims 18 to 26 in which the weight distribution of the sheath/core components is from about 10:90 to 90:10, typically from about 30:70 to 70:30, and preferably from about 40:60 to 65:35.

28. A process according to any of claims 18 to 27 in which the filaments are spun using either conventional melt spinning or short spinning, but preferably conventional melt spinning.

29. A process according to any of claims 18 to 28 in which the fibres have a circular, oval or irregular cross-section, and preferably a circular cross-section.

30. A process according to any of claims 18 to 29 in which the two components are arranged in a concentric or acentric configuration.

31. A process according to any of claims 18 to 30 in which the bundle of filaments is stretched using an off-line stretching process.

32. A process according to any of claims 18 to 31 in which the stretch ratio is about 2.5:1 - 4.5:1, and preferably about 3.0:1 - 4.0:1.

33. A process according to any of claims 18 to 32 in which the fibres are stretched to a fineness of about 1 - 7 dtex, typically about 1.5 - 5 dtex, preferably about 1.7 - 3.3 dtex, and more preferably about 1.7 - 2.2 dtex.

5 34. A process according to any of claims 18 to 33 in which the fibres are texturized to a level of about 0 - 10 crimps/cm, and preferably about 0 - 4 crimps/cm.

35. A process according to any of claims 18 to 34 in which the fibres are cut to a length of about 3 - 24 mm, typically about 5 - 20  
10 mm, preferably about 6 - 18 mm.

36. A process according to claim 35 in which the fibres are cut to a length of about 6 mm.

37. A process according to claim 35 in which the fibres are cut to a length of about 12 mm.

Fig. 1

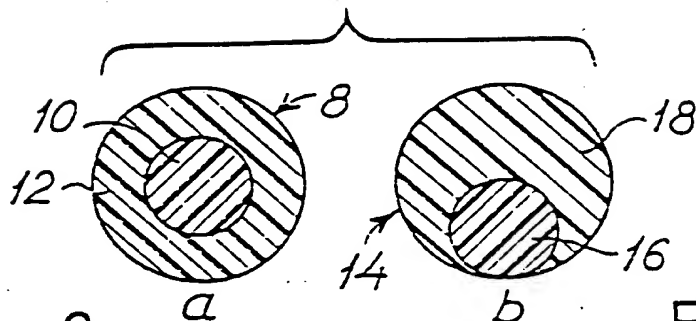


Fig. 2

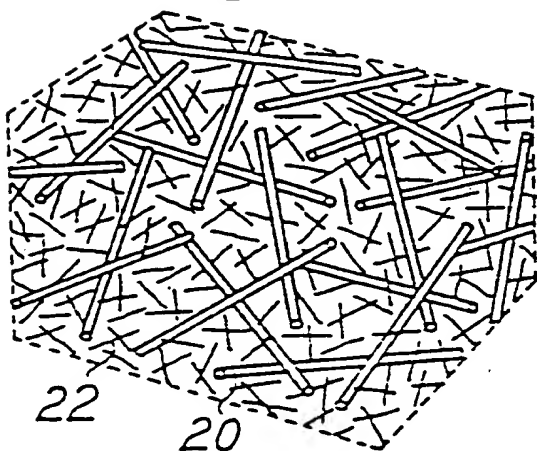
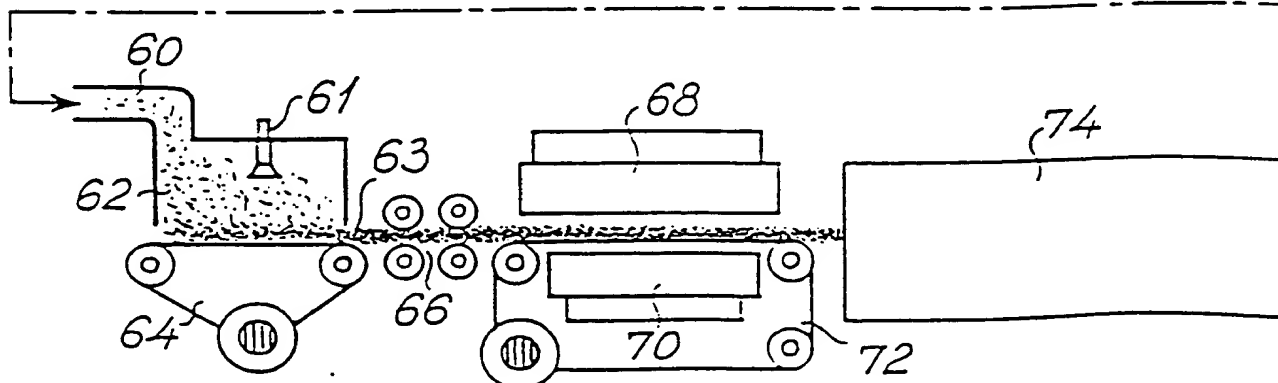
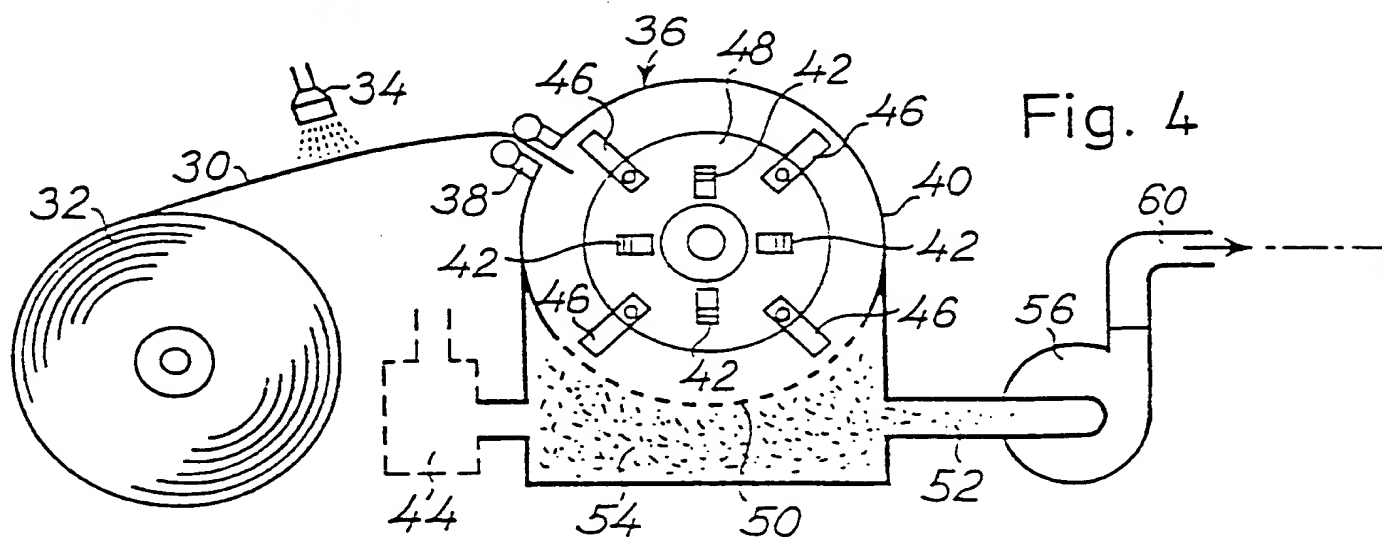
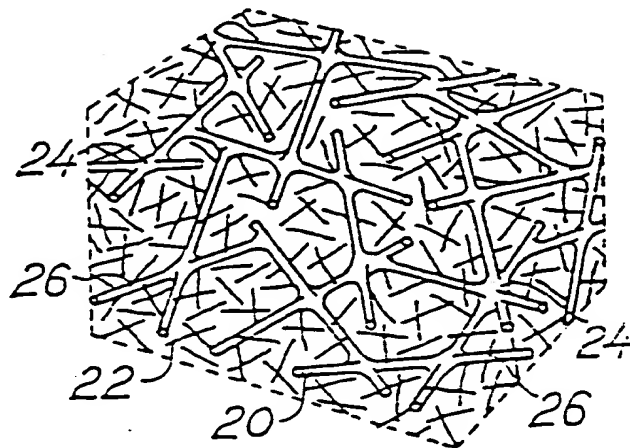


Fig. 3



Page Blank (uspto)

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/DK89/00102

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC \*

D 01 F 8/06

## II. FIELDS SEARCHED

Minimum Documentation Searched \*

Classification System \*

Classification Symbols

IPC 4

D 01 F

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched \*

SE, NO, DK, FI classes as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT \*

Category \* | Citation of Document, \*\* with Indication, where appropriate, of the relevant passages \*\* | Relevant to Claim No. \*\*

- |   |  |      |
|---|--|------|
| X | EP, A2, 0 093 021 (MONTEDISON S.P.A.)<br>2 November 1983<br>see the whole document<br>& JP, 58203118<br>CA, 1195813<br>US, 4710336 | 1-39 |
| X | EP, A2, 0 132 110 (CHISSO CORPORATION)<br>23 January 1985<br>see the whole document<br>& JP, 60021908<br>DE, 3468448               | 1-39 |
| X | EP, A2, 0 260 607 (CHISSO CORPORATION)<br>23 March 1988<br>see the whole document<br>& JP, 63075115                                | 1-39 |

\* Special categories of cited documents: 10

-A- document defining the general state of the art which is not considered to be of particular relevance

-E- earlier document but published on or after the international filing date

-L- document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

-O- document referring to an oral disclosure, use, exhibition or other means

-P- document published prior to the international filing date but later than the priority date claimed

-T- later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

-X- document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

-Y- document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

-A- document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

1989-07-21

Date of Mailing of this International Search Report

1989-07-26

International Searching Authority

Swedish Patent Office

Signature of Authorized Officer

Jack Hedlund

## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	GB, A, 2 096 048 (AKZO NV) 13 October 1982 see the whole document & FR, 2498634 DE, 3202485 JP, 57176217 CA, 1175219 US, 4552603	1-39
X	GB, A, 2 180 543 (CHISSO CORPORATION) 1 April 1987 see the whole document & JP, 62069822 DE, 3631960 US, 4789592	1-39
X	US, A, 4 234 655 (K. KUNIMUNE ET AL.) 18 November 1980 see the whole document & FR, 2368554 DE, 2747177 GB, 1552520 JP, 53061720 AU, 511351 US, 4323626 SE, 7711776 SE, 431996 JP, 53074129 JP, 53126320	1-39
X	US, A, 4 477 516 (T. SUGIHARA ET AL.) 16 October 1984 see the whole document & DE, 3323467 JP, 59009255 GB, 2125458	1-39
X	US, A, 4 732 809 (R.D. HARRIS JR. ET AL.) 22 March 1988 see the whole document	1-39



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**

**This Page Blank (uspto)**